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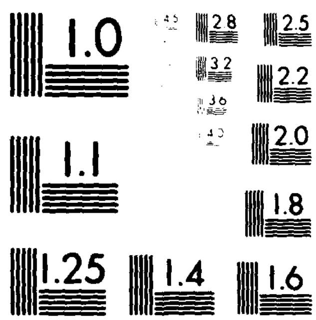


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Technical Memorandum 9-80

# A SUMMARY OF CAPABILITIES OF ARTILLERY FORWARD OBSERVERS EQUIPPED WITH LASER RANGEFINDERS

William J. Dousa, Jr.

May 1980
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| Tripod | AN/GVS-5 | Forward Observer |
| Tracking Tripod | Northfinder | FIST |
| Laser Rangefinder | Azimuth Measuring Device | |
| Viscous Damping | Modular Universal Laser Equipment (MULE) | |
| Ground Laser Locator Designator (GLLD) | | |

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)


The purpose of the report is to show the need for a tripod for use with an artillery rangefinder.

The data summarized in this report show that a laser rangefinder mounted on an azimuth measuring, aided tracking tripod increases a forward observer's ability to locate targets and to deliver fire-for-effect and adjust fire effectively.


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May 1980

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## CONTENTS

## EXECUTIVE SUMMARY

The data summarized in this report show a laser rangefinder on a tripod improves the target location accuracy of a forward observer (FO) from approximately 500 meters to 25 meters. This in turn increases the accuracy of fire-for-effect missions from about 250 meters to 100 meters. In addition, use of the laser/tripod system minimizes the need for precision registrations, reduces the number of rounds required in adjust fire missions and increases the effectiveness of fire-for-effect rounds after adjustment.

A northfinding device would not increase the accuracy of the GVS-5 laser rangefinder/tripod system. It may increase the capability of the GLLD and MULE but further study in this area is required.

The US Army Human Engineering Laboratory (USAHEL) believes the AN/TAS-4 nightsight is required to match the projected mission needs of the FO. USAHEL also believes that a limited night-fighting capability may be adequate and that all platoon FO's may not need to be equipped with this nightsight.

In order to get the improved capability of the laser/tripod and retain portability, it may be possible to trade off items from the basic combat load (i.e., .45 pistol for M16).

Overall, USAHEL feels that the tripod is very important in contributing to an artillery FO's effectiveness and that the factors of portability and cost should not hinder the acquisition of this capability.

## A SUMMARY OF CAPABILITIES OF ARTILLERY FORWARD OBSERVERS

## EQUIPPED WITH LASER RANGEFINDERS

### INTRODUCTION

This report summarizes the information collected by the Fire Support and Target Acquisition Directorate, US Army Human Engineering Laboratory, on the capabilities of forward observers (FOs) when they are provided new equipment. This equipment includes GVS-5 laser rangefinders, tracking tripods with angle readouts, ground laser locator designators (GLLD), azimuth measuring devices (AMD), and nightsights.

### ISSUE

The issue discussed in this summary is the FO's ability to bring effective fire onto targets. Data presented apply to platoon observers and fire support team (FIST) chiefs, as well as other forward targeting teams.

### SUMMARY OF FORWARD OBSERVER CAPABILITIES

In order to examine improvements in this ability by using a laser rangefinder or a laser rangefinder on a precision tracking tripod, three factors must be examined: (a) the observer's ability to locate targets, (b) fire-for-effect mission accuracy, and (c) the observer's ability to adjust fire.

a. Target Location Ability

Target location depends on the observer's ability for self-location, measuring the distance to the target and determining the direction to the target.

(1) Conventional Forward Observer (FO) Self Location

The present day observer generally uses a combination of map spot and reference points for self location. These present day techniques are well documented (see Table 1).

TABLE 1

Forward Observer's Ability to Map Spot OP[a] Location

| Source | Error in Self-Location in Meters |
|---|---|
| WESTEA-FO | 213 |
| ARTS-TEA-78 | 340 |
| HELBAT 1 | 146 |
| HELBAT 2 | 93 |
| HELMST | 204 |
| GLLD OT II | 155 |
| AMSAA/CDEC | 290 |

[a]Observation Post

While any statistical combination of these results is impossible (due to varying measures, "n" sizes, etc.), it is clear that the forward observer's ability for self location is approximately 200 meters.

(2) Forward Observer Self Location with Tripod Mounted Laser Rangefinder

With the advent of laser rangefinders, several techniques have been developed to allow the FO to self locate more accurately. All of these techniques require the use of at least a tripod with an azimuth measuring capability. The simplest of these techniques involves a backplotting of the FO from two known points. The FO locates two clearly identifiable points (generally manmade) on his map and in his field-of-view and then measures the distance to each with the rangefinder. The angle between the points is then measured with the azimuth scale. These data are transmitted to the fire direction center (FDC) (generally by voice/radio). The FDC backplots him and sends him his grid and an accurate reference azimuth to one of the targets. Several tests have provided data on this technique, as shown in Table 2. (The most accurate backplotting method requires use of a highly sophisticated viscous-damped, electromechanical tripod with direct digital interface with an FDC computer [HELBAT 5 and HELBAT 6 data in Table 2].)

Again, it would be improper to statistically summarize these data. However, it is apparent that the FO's can determine his location to within 50 meters.

Other techniques have been developed using a tripod-mounted laser rangefinder. These techniques are not described in detail in this report, but Table 3 provides an indication of the capability of these methods.

TABLE 2

Forward Observer's Ability for Self Location Using a Tripod-Mounted Laser and Two Known Points

| Source | Error in Self Location in Meters |
|---|---|
| GVS-5 OT II (w/tripod) | 65 |
| HELBAT 2 | 37 |
| HELBAT 3 | 31 |
| GLLD OT II | 113 |
| HELBAT 5[a] | 14 |
| HELBAT 6[a] | 19 |

[a]Used an automated (GLLD/DMD/battery computer) version of this technique.

TABLE 3

Forward Observer's Ability for Self Location Using a Tripod-Mounted Laser and Alternate Methods

| Source | Error in Self Location in Meters |
|---|---|
| 1 Known Point/1 Round | 30 |
| 2 Rounds | 50 |
| 2 Illumination Rounds | 39 |
| Helicopter | 7 |
| White Phosphorous Rounds | 52 |
| 1 Known Point/Northfinder | 9 |

(3) Conventional Forward Observer Target Location Ability

Once the FO has determined the OP location, the target must then be located. Conventional FO's generally map spot targets from their locations. Data on this capability are shown in Table 4.

TABLE 4

Forward Observer's Ability to Map Spot Target Locations

| Source | Error in Target Location in Meters |
|---|---|
| WESTEA-FO | 674 |
| ARTS-TEA 78 | 881 |
| GLLD OT II | 358 |
| HELMST | 458 |
| HELBAT 1 | 490 |
| HELBAT 2 | 313 |
| HELBAT 3 | 334 |

These data show the conventional FO has the ability to locate targets with an accuracy of about 500 meters.

(4) Forward Observer with Laser Rangefinder Target Location Ability (Range Only)

Three tests have examined the ability of an FO to improve his target location by using a tripod-mounted laser rangefinder to measure range only. The azimuth ring on the tripod used during these tests was oriented using an M2 compass and targets were polar plotted from the FO's map spot location. The results from these three tests are shown in Table 5.

TABLE 5

Forward Observer's Ability to Locate Targets Using a Laser to Measure Range Only

| Source | Error in Target Location in Meters |
|---|---|
| HELMST | 229 |
| GLLD OT II | 299 |
| GVS-5 OT II | 200 |

The FO in these tests used a tripod-mounted rangefinder to measure range. If the FO had used the rangefinder in the handheld mode, the accuracies would, most likely, have been degraded from those shown in Table 5.

(5) Forward Observer with Laser Rangefinder/Tripod Target Location Ability (Range and Azimuth)

The FO's ability to locate targets by using the laser rangefinder/tripod capability to measure azimuth as well as range (two known points, reference azimuth, laser range) is shown in Table 6.

TABLE 6

Forward Observer's Ability to Locate Targets Using Laser/Tripod and Backplotted Forward Observer Location

| Source | Error in Target Location in Meters |
|---|---|
| HELBAT 2 | 21 |
| HELMST | 13 |
| HELBAT 5[a] | 15 |
| HELBAT 6[a] | 21 |

[a]Used automated FO location and digital data transmission.

b. Fire-For-Effect Missions

All of the above improvements are worthless if they do not improve the forward observer's ability to effectively engage targets with indirect artillery fire. One method of engaging targets is to mass first rounds on the target in a fire-for-effect mission.

(1) Conventional Forward Observer Fire-For-Effect Mission Accuracy (With Registration)

The conventional method of fire-for-effect is to conduct a precision (ABCA) registration, which is a time- and ammunition-consuming effort. After this, the FO transfers fire-for-effect directly onto the target. Data are presented in Table 7 from several sources showing artillery's capability to achieve mission accuracy.

TABLE 7

Artillery's Ability to Deliver Fire-For-Effect After Precision Registration

| Source | Circular Probable Error in Meters |
|---|---|
| ORO Data | 150 |
| British Data | 153 |
| HELBAT 1 | 150 |
| HELBAT 2 | 160 |
| HELBAT 3 | 172 |

(2) Conventional Forward Observer Fire-For-Effect Mission Accuracy (Without Registration)

If no precision registration (a time- and ammunition-consuming effort) is conducted prior to a fire-for-effect mission fired by a conventional FO, the errors grow considerably, as shown in Table 8.

TABLE 8

Artillery's Ability to Deliver Fire-For-Effect Without Registration

| Source | Circular Probable Error in Meters |
|---|---|
| HELBAT 5 | 345 |
| HELBAT 6 (105mm) | 266 |
| HELBAT 6 (155mm) | 173 |

(3) Forward Observer with Laser Rangefinder/Tripod Fire-For-Effect Mission Capability (With Registration)

If the FO uses a laser rangefinder on a tripod (with its inherent improved FO location and reference azimuth) to conduct a fire-for-effect mission without first conducting a registration, the errors are considerably reduced from those of the conventional FO. The laser FO's accuracy in conducting this mission is shown in Table 9.

TABLE 9

Artillery's Ability to Deliver Fire-For-Effect Without Registration When Using a Laser Rangefinder/Tripod for Target Location

| Source | Circular Probable Error in Meters |
|---|---|
| HELBAT 2 | 130 |
| HELBAT 3 | 147 |
| HELBAT 5 | 65 |
| HELBAT 6 (105mm) | 100 |
| HELBAT 6 (155mm) | 108 |

It should be noted that mission accuracy of FO's using laser range-finder/tripod without registration is 50% better than conventional fire-for-effect missions with a prior registration (Table 9 versus Table 7).

c. Adjust Fire Missions

Another common mission used to engage artillery targets is adjust fire.

(1) Conventional Forward Observer Adjust Fire Mission Accuracy

Conventional FO adjust fire mission accuracy has been documented, as shown in Table 10.

TABLE 10

Conventional FO's Ability to Adjust Fire Onto a Target

| Source | Number of Adjust Rounds Prior to FFE | Circular Probable Error in Meters |
|---|---|---|
| HELBAT 2[a] | 7.7 | 96 |
| HELBAT 5[b] | 3.0 | 130 |

[a]Used the "bracket" method of adjustment.
[b]Used the "bold shift" method of adjustment.

(2) Forward Observer with Laser Rangefinder

During HELBAT 6, we allowed the FO to use a laser rangefinder/tripod to locate targets without FDC assistance and then use the conventional (bold shift) adjustment onto the target. Data for this technique is shown in Table 11.

TABLE 11

Conventional FO's Ability to Adjust Fire Onto a Target Using a Laser Rangefinder/Tripod Independently

| Source | Number of Adjust Rounds Prior to FFE | Circular Probable Error in Meters |
|---|---|---|
| HELBAT 6 (105mm) | 3 | 61 |
| HELBAT 6 (155mm) | 3 | 49 |

During HELBAT's 2, 5, and 6 we also ran "laser adjust" missions where, after locating the target with the laser, the FO lased on each round as it impacted and transmitted the distance, direction, and vertical angle to the FDC. The FDC computed the correction and adjusted gun orders appropriately. Data for the laser adjust technique is shown in Table 12.

TABLE 12

Ability of Forward Observer Using "Laser Adjust" to Bring Fire Onto a Target

| Source | Number of Adjust Rounds Prior to FFE | Circular Probable Error in Meters |
|---|---|---|
| HELBAT 2 | 3.3 | 73 |
| HELBAT 5 | 3.0 | 52 |
| HELBAT 6 (105mm)[a] | 2.0 | 28 |
| HELBAT 6 (155mm)[a] | 2.0 | 46 |

[a]Used automated laser adjust (GLLD/DMD/battery computer)

By comparing conventional FO with laser adjust (Table 10 versus Table 12), it is shown that the laser rangefinder/tripod combination can reduce the fire-for-effect errors in adjust fire missions by 50%. This 50% improvement is critical since it represents the difference between rounds having no effect on the target and rounds having an effect on the target.

In conclusion, USAHEL feels that the addition of a tripod mounted laser, with its improved stability and accuracy, provides a worthwhile improvement in the FO's ability to bring either fire-for-effect or adjust fire onto a target.

## AZIMUTH MEASURING DEVICE

HELBAT data show there are effective methods of orienting a tripod to much greater accuracy than the 30-50 mils which can be accomplished with the M2 compass. The most promising method is the two known-point technique which requires the FO to have only the laser rangefinder and the tripod. A northfinding device (AMD) is being proposed for use with the MULE tripod, but further study must be done to determine if there is any improvement in the ability to bring effective fire onto targets by its use. It appears that the MULE and GLLD may benefit from use of an AMD because of their laser precision. However, the AMC would not increase accuracy of the GVS-5 laser rangefinder/tripod system because the GVS-5's ability to measure range (with its 1-mil beam) is the system's limiting factor.

## PORTABILITY

USAHEL feels the portability issue should be further studied. Based on the HELFOTT study and other portability work which USAHEL has done, there are alternatives to be considered. One possibility is to have one member of the platoon FO team carry a caliber .45 pistol rather than an M16. This would eliminate over 10 pounds of weight (14.24 pounds for a loaded M16 and two 30-round clips versus 3.93 pounds for a loaded .45, holster, and two 9-round clips). This single trade-off would almost compensate for the 16 pounds presently estimated for the MULE tripod. Considering the relative importance of the tripod versus the M16 for the accomplishment of the FO team's job, this seems to be a worthwhile trade-off.

## NIGHTSIGHTS

Of the two candidate nightsight systems, the AN/TVS-5 and the AN/TAS-4, USAHEL believes the AN/TAS-4 is required to match the projected mission needs of the platoon FO. USAHEL also believes that a limited night fighting capability may be adequate and that all platoon FO's may not need to be equipped with this nightsight; however, this requires further study. For FO's equipped with the nightsight, it can be left stowed in the deployment vehicles until occupation of night positions.

## FUTURE CAPABILITY

All of the data presented in this report applies to capability of present day equipment. If we look to the near future when FIST platoons carry digital message devices (DMD) and the FDC employs a battery computer system (BCS), the addition of a viscous-damped digital readout tripod to the modified GVS-5 will provide several more improvements:

a. Rapid fire-mission data transmission using the DMD's digital interface port.

b. The laser rangefinder/viscous-damped digital readout tripod, in conjunction with the automatic prediction capability of the BCS, will provide an effective moving target engagement capability.

## SUMMARY

The data summarized in this report show that a laser rangefinder on a tripod increases the target location accuracy of an FO from approximately 500 meters to 25 meters. This, in turn, increases the accuracy of fire-for-effect missions from about 250 meters to 100 meters. In addition, use of the laser/tripod system minimizes the need for precision registrations, reduces the number of rounds required in adjust fire missions and increases the effectiveness of fire-for-effect rounds after adjustment.

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In order to get improved capab.lity of the laser/tripod and retain portability, it may be possible to trade off items from the basic combat load (i.e., .45 pistol for M16).

Overall, USAHEL feels that the tripod is <u>very</u> important in contributing to an artillery FO's effectiveness and that the factors of portability and cost should not hinder its acquisition.

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